Title: Electrolyte Diffusion and Gatorade vs. Powerade Extension

Brief Overview:

This lesson will demonstrate the permeability of electrolytes through a semi-permeable membrane. The first lesson uses table salt solution and a conductivity meter to show the flow of the electrolyte (salt) through dialysis tubing. The data will be analyzed by using the calculator to find the line of best fit, through regression analysis. By finding the slope the student can then determine the rate of diffusion (rate of change). Further studies would use various beverages as test materials.

Link to Standards:

- **Problem Solving** Students will demonstrate the ability to solve problems outside the discipline of mathematics through data collection and interpretation of graphs.
- **Reasoning** Students will predict the validity of tests for permeability based on conductivity.
- **Connections** Students will demonstrate their ability to make comparisons between the conductivity of distilled water and that of the resultant solution after diffusion has taken place.

Grade/Level:

Grades 9-10

Duration/Length:

This lesson will take 2 periods (45 min.).

Prerequisite Knowledge:

Students should have a working knowledge of the following:

- The TI-82 or TI-83 calculator and CBL unit
- Computer skills
- How to utilize graphs
- The slope-intercept form of the equation of a line

Objectives:

Students will be able to:

- work cooperatively in groups.
- collect and organize data from CBL.
- use the TI calculator.
- set up and perform the experiment.
- recognize the application of slope.

Materials/Resources/Printed Materials: (per student group)

- Salt Water (1%)
- Beaker (250 ml)
- Dialysis Tubing (12 cm)
- 2 pieces of string (12 cm each)
- Distilled water
- Small lab funnel
- TI-82 or TI-83 graphics calculator and manual
- CBL with conductivity probe (DIN Adaptor needed)
- Conductivity program (Chemistry with CBL, Vernier)
- TI-Graph - Link

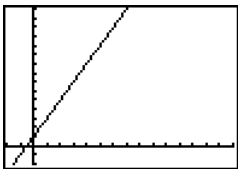
Development/Procedures:

- Form groups of students to work cooperatively; 3-4 students maximum per group.
- Attach CBL and calculator with link cord.
- Attach the conductivity probe to the CBL in channel one.
- Set the toggle switch on the conductivity box to 0-200
- Call up CHEM program on the calculator, press enter.
- Press enter again.
- Select #1 (set up probes), press enter.
- Enter 1 for # of probes, press enter.
- Select #6 (conductivity), press enter
- Enter 1 for channel #, press enter
- Select #3 (use stored) for calibration, press enter
- Select #2 (collect data) , press enter.
- Select #2 (time graph) for data collection, press enter
- Enter 10 for time between seconds, press enter.
- Enter 24 for number of samples, press enter.
- Press enter again.
- Select #1 (Use Time Setup), press enter
- Enter (-2) for Ymin, press enter
- Enter (5) for Ymax, press enter

- Enter (.5) for Yscl, press enter
- Place conductivity probe into beaker containing 150 ml of distilled water.
- Set calculator and CBL aside until ready for experiment to begin.
- Obtain a soaked dialysis tubing bag from the teacher.
- Make a dialysis tubing bag by tying one end of the tubing tightly with string.
- Open the dialysis tubing by rubbing the tubing between your index finger and thumb.
- Use the funnel to help fill the bag 3/4 full with the salt water mixture.
- Tie the top of the dialysis tubing with second piece of string.
- Rinse outside of bag with distilled water and hold the tube by the end until placed in the beaker, (do not contaminate the outside of the tube by touching or placing on the counter!). DO NOT PLACE THE PREPARED DIALYSIS TUBING BAG INTO THE BEAKER UNTIL TOLD TO DO SO.
- Press enter on the calculator to collect beginning reading.
- After approximately ten seconds place dialysis tubing in the beaker of distilled water, leaving the conductivity probe in the beaker.
- As the experiment proceeds, gently swirl the probe in the distilled water, periodically. CAUTION : DO NOT LIFT THE PROBE FROM THE BOTTOM OF THE BEAKER.
- Allow the experiment to run undisturbed for 4 minutes and the CBL has signaled "DONE".

Evaluation:

1. (Complete the following as a group.) Using the graph of the data on your screen, compare it to the four examples below and pick the type of equation whose graph best matches the shape of the data. Record your answer.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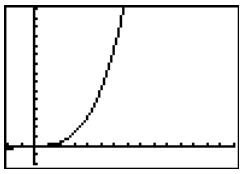
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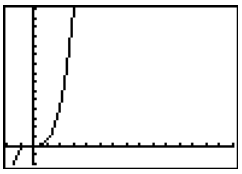
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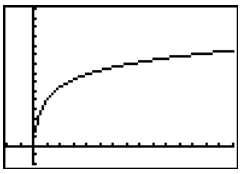
LnReg

2. Quit the program and go back to the home screen. Your data is in list L1 and L2. Using the type of curve selected in step one, you will have the calculator write a regression equation. Now overlay the graph of this equation over the scatter plot of the data. Print this screen and L1 and L2 using the TI-Graph Link. You will turn this in.

3. Notice that the middle of your data looks like a straight line. Find the slope by picking two data points from that part the line that are relatively far apart. Use trace to get the coordinates of the two points and then calculate the slope of the line between them. Record your result and your responses to the following questions.

    a. What would it mean when the slope is zero? Is there a point where the slope became zero?

    b. What would it mean if the slope increases or decreases?

    c. What does your group feel slope represents?

4. You will now use the calculator to write the equation of that part of the line. Look at your data and decide which points are not part of "this line". Go to the end of L1 and L2 and delete these points. Now use stat mode and write a liner regression equation of the remaining data in L1 and L2. Looking at your results what is the slope of this segment? Record your answer. How does it compare with your answer in #3? Why might they not be the same?

5. Turn your computer printouts and answers in to your teacher.

Extension/Follow Up:

1. Use various types of electrolyte drinks in the place of the salt water. Examples of electrolyte drinks would be Gatorade®, Powerade®, Pedialyte®, 1st ade®, All Sport®.

2. The conductivity probe can be used as a meter to take single measurements to measure the conductivity of various beverages, such as those suggested above, or soda pops, coffee, tea, and tap water.

Authors:

Aline Novak	Scott Horning	Linda Clark
Clear Spring High	Clear Spring High	Williamsport High
Washington County, MD	Washington County, MD	Washington County, MD

TEACHER NOTES

This lesson requires the use of the program from Chemistry with CBL™; Dan D. Holmquist, Jack Randall and Donald L. Volz; Vernier Software, Portland, Oregon 97225-24289; 1995.

1. Load the "CHEM" program from Chemistry with the CBL to all TI-82 or 83 calculators. (One option would be to load only one calculator and then have students link and send to receive the program.)
2. Attach the DIN adapter to the conductivity probe.
3. Cut pieces of dialysis tubing into approximately 12 cm pieces.
4. Soak the dialysis tubing in a beaker of distilled water for about one hour until ready for use. Wet dialysis tubing must remain in distilled water to keep it pliable, (it can remain in the water for several days).
5. Prepare the salt water solution by adding 1 gram of NaCl (table salt) to 100 ml of distilled water. Prepare the amount needed for your class. Each student group will use about 20 ml.
6. Gatorade can be added to the dialysis tubing in place of the salt water, to show its diffusion, and to compare it to the salt water.
7. Evaluation: The student should recognize this as a LnReg model.

BACKGROUND

Diffusion

The process of diffusion is the flow of a substance from one of a higher concentration into one of a lower concentration. An example of diffusion: If someone sprays perfume in the front of the room, in a few minutes the smell has spread to the rear of the room.

The rate of diffusion is effected by the concentration of material, pressure and temperature. The conductivity probe self-adjusts for temperature change. In this experiment, the concentration of 1% NaCl and pressure remain the constant.

Dialysis tubing

Dialysis tubing works similar to a cell membrane. It allows molecules to cross through the tubing into the surrounding solution.